SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering in Mechatronics.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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THREAT ASSESSMENT ANALYSIS FOR VEHICLE COLLISION AVOIDANCE

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ABSTRACT

This thesis presents a threat assessment analysis for collision avoidance just before an accident. This is due to the high rate of accidents that happened in Malaysia for the past years. The outcome of this research is to simulate the vehicle's maneuver trajectory to prevent accidents. Besides that, possible impacts of the accidents will be estimated for threat assessment analysis. This project also provides an appropriate decision making for the driver by assessing different vehicle's maneuver conditions. There are different cases of avoidance such as the driver of a vehicle can use braking, acceleration or steering to avoid a collision with an obstacle model. An intelligent threat analysis is proposed to estimate the possible position of the main vehicle to generate a minimum impact force of potential accidents. The analysis proposed will help the driver to make decision to avoid an obstacle. In addition, the environment uses MATLAB/Simulink for simulation to estimate the position. The simulation includes system blocks of vehicle dynamics, kinematics of a car and obstacle modelling. Simulation results and theoretical value of impact forces are able to determine the suitable position of vehicle to avoid obstacles.

ABSTRAK

Projek ini menerangkan tentang penilaian ancaman analisis bagi mengelakkan perlanggaran antara kenderaan. Projek ini dilaksanakan oleh kerana kadar kemalangan yang tinggi di Malaysia sejak beberapa tahun yang lalu. Dapatan kajian yang dilakukan ini adalah bagi mensimulasikan trajektori kenderaan bagi mengelakkan perlanggaran. Selain itu, impak perlanggaran akan dinilai bagi tujuan penilaian ancaman analisis. Projek ini juga membantu dalam memberi keputusan yang sesuai untuk pemandu dengan menilai cara mengelak perlanggaran. Terdapat pelbagai cara untuk mengelakkan perlanggaran sesama kenderaan. Antaranya ialah pemandu boleh menekan brek, menekan pedal minyak atau memusing stereng kereta bagi mengelakkan perlanggaran. Penilaian ancaman analisis telah diusulkan untuk membuat keputusan dan anggaran tentang kedudukan kereta bagi mengelak perlanggaran atau membuat perlanggaran dengan minima impak terhadap pemandu. Tambahan pula, perisian Matlab/Simulink akan digunakan sebagai perisian simulasi bagi menentukan kedudukan kereta tersebut. Simulasi yang akan dilakukan termasuklah kenderaan model dinamik, model kinematik dan model halangan. Hasil keputusan simulasi dan nilai teori daya impak dapat menentukan kedudukan kenderaan yang sesuai bagi mengelakkan halangan.

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LIST OF SYMBOLS

F	Force
m	Mass
a	Acceleration
d	Distance
t	Time
$\dot{V}x$	Longitudinal acceleration
$\dot{V}y$	Lateral acceleration
Vx	Longitudinal velocity
Vy	Lateral velocity
Fx fr , Fy fr	Forces of Fx and Fy at front right wheel
Fx fl , Fy fl	Forces of Fx and Fy at front left wheel
Fx rr , Fy rr	Forces of Fx and Fy at rear right wheel
Fx rl , Fy rl	Forces of Fx and Fy at rear left wheel
δ	Steering angle
m	Mass of vehicle
$\ddot{r}$	Yaw motion
$\dot{r}$	Yaw rate
w	Vehicle track width
Lf	Length from vehicle COG to front wheels
Lr	Length from vehicle COG to rear wheels
V	Longitudinal velocities
U	Lateral velocities

R	Radius of curvature of the road
θ	Vehicle's orientation
$\dot{x}_c$	Curvature of x direction
$\dot{y}_c$	Curvature of y direction

LIST OF ABBREVIATIONS

MIROS	Malaysian Institute of Road Safety Research
SA	Steering angle

CHAPTER 1

INTRODUCTION

1.1 Background of the Project

Malaysia has high rate of vehicle accidents involving some degree of driver behavior [1]. Figure 1.1 shows the road accident data in Malaysia. Number of road crashes increase every year as shown in the figure below. In the year 2013, MIROS recorded a total of 477,204 road crashes. A total of 6917 road deaths were recorded in the year 2012. The behavior of the implicated driver is usually the primary cause. This includes driver fatigue, drowsiness or lacking of response time which may lead to accidents. Therefore, in order to prevent such accidents from happening, an intelligent threat assessment analysis will be created.

A student needs to design and create an analysis for threat assessment of wheeled mobile robot. Parameters such as speed, mass of vehicle, impact force are needed to estimate the possible output. The output involve is the suitable position of host vehicle during or to avoid a collision. The simulations will be done using Matlab with different cases of possible collisions/accidents. A decision made for the vehicle to avoid collisions or accidents are based on the output obtained which is impact force and time of collision. The expected outcome of this project is to generate an analysis for threat assessment to prevent accidents by simulation.

Year	Registered Vehicles	Population	Road Crashes	Road Deaths	Serious Injury	Slight Injury	Index per 10,000 Vehicles	Index per 100,000 Population	Indeks per billion VKT
1997	8,550,469	21,665,600	215,632	6,302	14,105	36,167	7.37	29.1	33.57
1998	9,141,357	22,179,500	211,037	5,740	12,068	37,896	6.28	25.8	28.75
1999	9,929,951	22,711,900	223,166	5,794	10,366	36,777	5.83	25.5	26.79
2000	10,598,804	23,263,600	250,429	6,035	9,790	34,375	5.69	26	26.25
2001	11,302,545	23,795,300	265,175	5,849	8,680	35,944	5.17	25.1	23.93
2002	12,068,144	24,526,500	279,711	5,891	8,425	35,236	4.9	25.3	22.71
2003	12,819,248	25,048,300	298,653	6,286	9,040	37,415	4.9	25.1	22.77
2004	13,828,889	25,580,000	326,815	6,228	9,218	38,645	4.52	24.3	21.1
2005	15,026,660	26,130,000	328,264	6,200	9,395	31,417	4.18	23.7	19.58
2006	15,790,732	26,640,000	341,252	6,287	9,253	19,885	3.98	23.6	18.69
2007	16,813,943	27,170,000	363,319	6,282	9,273	18,444	3.74	23.1	17.6
2008	17,971,901	27,730,000	373,071	6,527	8,868	16,879	3.63	23.5	17.65
2009	19,016,782	28,310,000	397,330	6,745	8,849	15,823	3.55	23.8	17.27
2010	20,188,565	28,910,000	414,421	6,872	7,781	13,616	3.4	23.8	16.21
2011	21,401,269	29,000,000	449,040	6,877	6,328	12,365	3.21	23.7	14.68
2012	22,702,221	29,300,000	462,423	6,917	5,868	11,654	3.05	23.6	13.35
2013	23,819,256	29,947,600	477,204	6,915	4,597	8,388	2.9	23.1	12.19
2014	25,101,192	30,300,000	476,196	6,674	4,432	8,598	2.66	22	10.64

Figure 1.1: General Road Accident Data in Malaysia (1997 – 2014) – Malaysian Institute of Road Safety Research (MIROS) [2]

1.2 Problem Statement

Driver's action just before an accident is able to cause major injury or high impact force to the driver. Experienced drivers are able to make decision in a critical situation in order to avoid collision. The action during the short response time includes braking, acceleration or steering to avoid accidents. An appropriate decision making of the driver needs to be correct in order to prevent accidents from happening.

1.3 Project Objectives

1. To simulate the vehicle's maneuver trajectory in order to prevent accidents.

2. To estimate the possible impacts of the accidents for threat assessment analysis.

3. To provide an appropriate decision making for the driver by assessing different vehicle's maneuver conditions.

1.4 Project Scope

1. Study of vehicle dynamics

   A good designed modeling of a system is needed in order to create an intelligent control system. Mathematical model of a vehicle is described in this thesis, which includes acceleration and braking. In addition to that, kinematic model is also described to obtain the position and coordinate of the vehicle in a certain instant.

2. Study of collision and impact

   Mathematical formula of collision and impact are needed to estimate the impact force of a collision. Different cases of driver's maneuver uses different mathematical formula to calculate each impact forces.

3. Matlab/Simulink

   Matlab is a software used for various simulations, signal processing or as a calculator. For this project, Simulink is used. It adds graphical multi-domain simulation and model-based design for dynamic and embedded systems. This is for the purpose of implementation of analysis.

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